Claims:

What is claimed is:

1. (amended) A semiconductor multi-layered structure having non-uniform quantum dots, characterized in that:

the structure has at least one layer of such quantum dots and;

the quantum dots in the layer are non-uniform quantum dots individually composed of compound semiconductor and different in both of size and compound semiconductor composition, and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least any of ultraviolet, visible light, and infrared light involving 1.3 and 1.5 μ m bands.

2. (amended) A semiconductor multi-layered structure having non-uniform quantum dots, characterized in that:

it is of a double hetero junction structure comprising an active layer, and a pair of clad layers laid on opposite sides of the active layer and larger in forbidden band than the active layer, and

the active layer includes at least one layer, and each of said non-uniform quantum dots is a non-uniform quantum dot individually composed of compound semiconductor and different in both of size and compound semiconductor composition, and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least any of ultraviolet, visible light, and infrared light involving 1.3 and 1.5 μ m bands.

3. (deleted)

4. (amended) A semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 2, characterized in that it is so structured that a plurality of such non-uniform quantum dot layers are embedded in the active layer.

5. (amended) A semiconductor multi-layered structure having non-uniform quantum dots as set forth in any one of claim 2 or claim 4, characterized in that:

the quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x$

$\leqq$ 0.6); and

the active layer is made of one of materials selected from the class consisting of InP, $Al_xIn_{1-x}As$ (where x = 0.27 to 0.65 and it has a forbidden band at room temperature of 0.95 eV to 1.9 eV), $Ga_xIn_{1-x}As_yP_{1-y}$ (where $0 < x < 1$ and $0 < y < 1$), and $Al_uGa_vIn_wAs$ (where u + v + w = 1, and it has a forbidden band at room temperature of 0.95 eV to 1.9 eV), and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least either of infrared lights involving 1.3 and 1.5 μ m bands.

6. (amended) A semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 2 or claim4, characterized in that:

the semiconductor multi-layered structure having the non-uniform quantum dots has a substrate made of InP;

the quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x \leqq 0.6$);

the active layer is made of $Al_xIn_{1-x}As$ (where x = 0.27 to 0.40 and it has a forbidden band at room temperature of 0.95 eV to 1.24 eV) or $Al_uGa_vIn_wAs$ (where u + v + w = 1, and it has a forbidden band at room temperature of 0.95 eV to 1.24 eV); and

the clad layers are made of $Al_xIn_{1-x}As$ (where x = 0.42 to 0.48 and it has a forbidden band at room temperature of 1.3 eV to 1.46 eV) or $Al_xGa_yIn_zAs$ (where x + y + z = 1, and it has a forbidden band at room temperature of 1.3 eV to 1.46 eV), and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least either of infrared lights involving 1.3 and 1.5 μ m bands.

7. (amended) A semiconductor multi-layered structure having non-uniform quantum dots as set forth in any one of claims 2 and claims 4 - 6, characterized in that the active layer is lattice-matching with the clad layers.

8. (amended) A light emitting diode using a semiconductor multi-layered structure having non-uniform quantum dots, characterized in that:

it comprises a p-type semiconductor layer and an n-type semiconductor layer which together form a pn diode; and a layer of non-uniform quantum dots contained in either a p-type or an n-type semiconductor layer,

each of said quantum dots is a non-uniform quantum dot individually composed of compound semiconductor and different in both of size and compound semiconductor composition, and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least any of ultraviolet, visible light, and infrared light involving 1.3 and 1.5 μ m bands,

whereby injecting current into said pn diode causes the non-uniform quantum dots to be excited, thereby emitting light therefrom in a multi of predetermined wavelengths.

9. (amended) A light emitting diode using a semiconductor multi-layered structure having non-uniform quantum dots, characterized in that:

it comprises an active layer containing a semiconductor multi-layered structure having non-uniform quantum dots; and

a double hetero junction structure comprising the active layer and clad layers formed at opposite sides of the active layer and larger in forbidden band than the active layer,

each of said quantum dots is a non-uniform quantum dot individually composed of compound semiconductor and different in both of size and compound semiconductor composition, and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least any of ultraviolet, visible light, and infrared light involving 1.3 and 1.5 μ m bands,

whereby injecting current into the double hetero junction structure causes the non-uniform quantum dots to be excited, thereby emitting light in a muti of predetermined wavelengths.

10. (deleted)

11. (deleted)

12. (amended) A light emitting diode using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 8 or claim 9, characterized in that said light emitting diode has a substrate made of InP; and said quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x \leqq 0.6$).

13. (amended) A light emitting diode using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in any one of claims 9, 11 and 12, characterized in that

said quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x \leqq 0.6$); and

said active layer is made of one of materials selected from the class consisting of InP, $Al_xIn_{1-x}As$ (where x = 0.27 to 0.65 and it has a forbidden band gap at room temperature of 0.95 eV to 1.9 eV), $Ga_xIn_{1-x}As_yP_{1-y}$ (where $0 < x < 1$ and $0 < y < 1$), and $Al_uGa_vIn_wAs$ (where $u + v + w = 1$, and it has a forbidden band gap at room temperature of 0.95 eV to 1.9 eV).

14. (amended) A light emitting diode using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 9, characterized in that:

the light emitting diode has a substrate made of InP;

the quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x \leqq 0.6$);

the active layer is made of $Al_xIn_{1-x}As$ (where x = 0.27 to 0.40 and it has a forbidden band gap at room temperature of 0.95 eV to 1.24 eV) or $Al_uGa_vIn_wAs$ (where $u + v + w = 1$, and it has a forbidden band gap at room temperature of 0.95 eV to 1.24 eV); and

the clad layers are made of InP.

15. (amended) A semiconductor laser diode using a semiconductor multi-layered structure having non-uniform quantum dots, characterized in that:

it comprises an active layer containing at least one layer of non-uniform quantum dots; and

a double hetero junction structure comprising the active layer and clad layers formed at opposite sides of the active layer and larger in forbidden band gap than the active layer,

each of said quantum dots is a non-uniform quantum dot individually composed of compound semiconductor and different in both of size and compound semiconductor composition, and said non-uniform quantum dots have a plurality of quantum levels as the

light emission center by current injection corresponding to multi wavelengths including at least any of ultraviolet, visible light, and infrared light involving 1.3 and 1.5 μm bands,

whereby injecting current into the double hetero junction

structure causes the non-uniform quantum dots to be excited, thereby bringing about laser oscillations in a multi of predetermined wavelengths.

16. (deleted)

17. (deleted)

18. (amended) A semiconductor laser diode using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 15, characterized in that

the semiconductor laser diode has a substrate made of InP;

the quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x \leqq 0.6$);

the active layer is made of $Al_xIn_{1-x}As$ (where x = 0.27 to 0.40 and it has a forbidden band at room temperature of 0.95 eV to 1.24 eV) or $Al_uGa_vIn_wAs$ (where u + v + w = 1, and it has a forbidden band at room temperature of 0.95 eV to 1.24 eV); and

the clad layers are made of $Al_xIn_{1-x}As$ (where x = 0.42 to 0.48 and it has a forbidden band at room temperature of 1.3 eV to 1.46 eV) or $Al_xGa_yIn_zAs$ (where x + y + z = 1, and it has a forbidden band at room temperature of 1.3 eV to 1.46 eV).

19. (amended) A semiconductor laser diode using a semiconductor multi-layered structure having non-uniform quantum dots as set forth

in claim 15 or claim 18, characterized in that the active layer is lattice-matching with the clad layers.

20. (amended) A semiconductor light amplifier using a semiconductor multi-layered structure having non-uniform quantum dots, characterized in that:

it comprises an active layer containing at least one layer of non-uniform quantum dots; and

a double hetero junction structure comprising the active layer and clad layers formed at opposite sides of the active layer and larger in forbidden band than the active layer,

each of said quantum dots is a non-uniform quantum dot individually composed of compound semiconductor and different in both of size and compound semiconductor composition, and said non-uniform quantum dots have a plurality of quantum levels as the light emission center by current injection corresponding to multi wavelengths including at least any of ultraviolet, visible light, and infrared light involving 1.3 and 1.5 μm bands,

whereby injecting current into the double hetero junction structure causes the non-uniform quantum dots to be excited, thereby amplifying light in a multi of predetermined wavelengths incident externally of the double hetero junction structure.

21. (deleted)

22. (deleted)

23. (amended) A semiconductor light amplifier using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 20, characterized in that

the semiconductor light amplifier has a substrate made of InP;

the quantum dots are made of $Ga_xIn_{1-x}As$ (where $0 < x \leqq 0.6$);

the active layer is made of $Al_xIn_{1-x}As$ (where x = 0.27 to 0.40 and it has a forbidden band at room temperature of 0.95 eV to 1.24 eV) or $Al_uGa_vIn_wAs$ (where u + v + w = 1, and it has a forbidden band at room temperature of 0.95 eV to 1.24 eV); and

the clad layers are made of $Al_xIn_{1-x}As$ (where x = 0.42 to 0.48 and it has a forbidden band at room temperature of 1.3 eV to 1.46 eV) or $Al_xGa_yIn_zAs$ (where x + y + z = 1, and it has a forbidden band at room temperature of 1.3 eV to 1.46 eV).

24. (amended) A semiconductor light amplifier using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claims 20 or claim 23, characterized in that the active layer is lattice-matching with the clad layers.

25. (amended) A method of making a semiconductor device using a semiconductor multi-layered structure having non-uniform quantum dots in a non-uniform quantum dot structure, characterized in that it includes the step of fabricating the non-uniform quantum dot structure for the semiconductor device by an epitaxial growth process that does not require lattice strain in forming non-uniform quantum dots, and said non-uniform quantum dot structure of a semiconductor device is formed by epitaxial growth process without requiring lattice strain, and in this case, said non-uniform quantum dot structure is formed by auto-termination mechanism of a droplet epitaxial growth process using either of MOCVD, MBE, gas source MBE, or MOMBE method.

26. A method of making a semiconductor device using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 25, characterized in that said semiconductor device is any one of a light emitting diode, a semiconductor laser diode and a semiconductor light amplifier.

27. (amended) A method of making a semiconductor device using

a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 25 or claim 26, characterized in that said non-uniform quantum dot structure of a semiconductor device is a non-uniform quantum dot individually composed of compound semiconductor and different in either one or both of size and compound semiconductor composition.

28. (amended) A method of making a semiconductor device using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 27, characterized in that said quantum dot structure consists of InAs, or $Ga_xIn_{1-x}As$ (where $0 < x \leq 0.6$).

29. (amended) A method of making a semiconductor device using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in claim 25, characterized in that said epitaxial growth process is MOCVD and the non-uniform quantum dot layer is formed by droplet epitaxial growth at a growth temperature lower than that at which other growth layers in the structure are formed.

30. (New) A semiconductor device, characterized in that it is manufactured by the method of manufacture of semiconductor devices using a semiconductor multi-layered structure having non-uniform quantum dots as set forth in any one of claims 25 - 29.